2660

CHEMICALS OF CONCERN

IN

NIAGARA RIVER TRIBUTARIES

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CHEMICALS OF CONCERN IN NIAGARA RIVER TRIBUTARIES 1988-89

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INTRODUCTION:

In 1986, as part of the Niagara River Toxics Management Plan assessment and remediation effort, the four principal agencies (Environment Canada (DOE), United States Environmental Protection Agency (USEPA), Ontario Ministry of Environment and Energy (MOEE) and the New York State Department of Environmental Conservation (NYSDEC)) proposed and initiated the Upstream/ Downstream Monitoring Program on the River (Niagara River Secretariat, 1990). The program is used to determine the differential loadings of an array of contaminants leaving the River at Niagara-on-the-Lake compared to those entering from Lake Erie at Fort Erie.

With the parallel monitoring of municipal and industrial point source discharges, it became apparent that inputs from Lake Erie plus measured point source discharges within the drainage basin could not account for all the contaminant loadings reaching Lake Ontario. The balance was attributed to non-point sources (i.e. contaminants arising from diverse and non-specific locations such as rural and urban runoff, groundwater inputs, and landfills), rather than from specific "end of pipe" discharges.

In 1988, the Ontario Ministry of Environment and Energy initiated an intensive one year sampling program at the mouths of thirteen tributary streams on the Canadian side of the River (Figure 1). The original intent of the study was to quantify contaminant loadings, if any, from the tributaries, and to identify the significant contributors of various contaminants. The tributary outflows were viewed as the point of delivery of the cumulative loading of all upstream point and non-point sources within each basin.

A contaminant loading may be defined as the amount of a contaminant substance being delivered to the River over a period of time, usually expressed in units of kilograms per day or per year. A loading is calculated by multiplying the measured concentration of the substance by the measured flow on the sampling date, over some time interval. A zero or imprecise result, such as "Not Detected", for either the contaminant concentration or streamflow, produces an unquantifiable loading result. A series of such unquantifiable results over the course of the study decreases the reliability of the total loading figure over an extended period of time.

In time, the calculation of loadings from these data, was proven to be an impossible task. Water quality data revealed many of the parameters tested were not detected at all or only sporadically. While such findings were very desirable from a water quality point of view, without real numerical data, the calculation of means or other basic statistics was unreliable. Similarly, on occasion some tributaries had no measurable flow, again rendering the calculation of loadings impossible.

As a result of these limitations, loading calculations were abandoned and this report will present and interpret the water quality data only as concentrations. It will focus on the Niagara

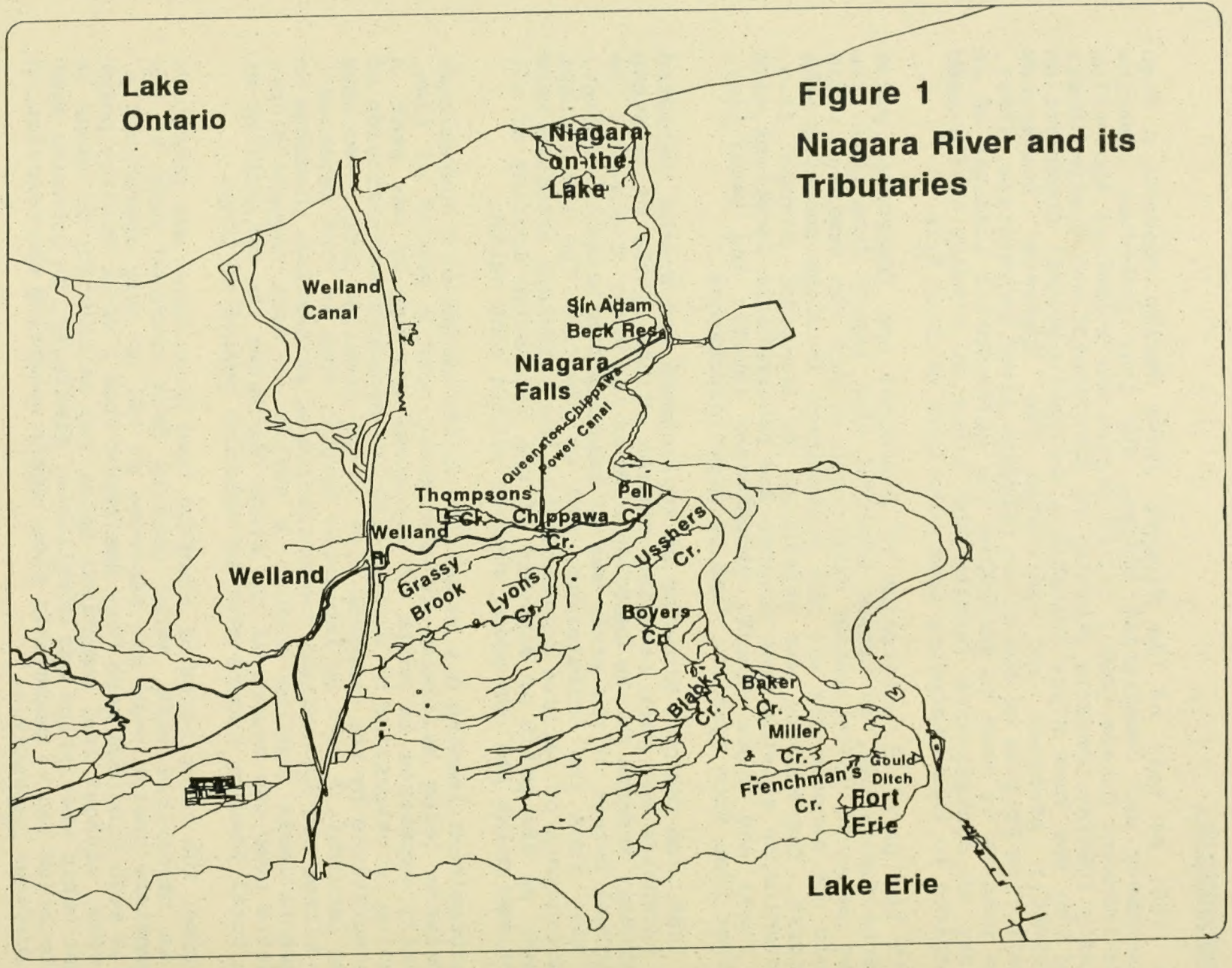

Figure 1

Niagara River and its Tributaries

River Toxics Management Plan (NRTMP) list of eighteen Chemicals of Concern (Table 1).

Table 1: CHEMICALS OF CONCERN IN THE NIAGARA RIVER AS IDENTIFIED BY THE NIAGARA RIVER TOXICS MANAGEMENT PLAN

Arsenic	Dioxin (2,3,7,8-TCDD)
Benz(a)anthracene	Hexachlorobenzene
Benzo(a)pyrene	Lead
Benzo(b)fluoranthene	Mercury
Benzo(k)fluoranthene	Mirex
Chlordane	Octachlorostyrene
Chrysene	PCB's (total)
DDT & Metabolites	Tetrachloroethylene
Dieldrin	Toxaphene

THE STUDY AREA:

Along its 58-kilometer length, the Niagara River receives less than 0.1% of its total volume of flow from the Welland River plus a number of smaller tributaries. The majority of the latter originate within a 10-kilometer wide band along the Upper River, draining primarily rural, low relief, clay soils. They are characterized by rapid runoff of precipitation, with little infiltration and consequently little contribution from groundwater. Flows are very seasonal, often intermittent especially in the smaller streams, and water clarity is generally turbid.

The Welland River is similar to these smaller streams in many respects, although much larger, its watershed encompassing about 900 square kilometers and originating some 70 kilometers to the west, south of the City of Hamilton. Agriculture predominates as the main land use throughout the basin.

Downstream from the Niagara Falls, only a strip of land approximately one kilometer wide drains to the Lower River, and there are no major tributaries.

The main population centers are the Cities of Niagara Falls and Welland, plus the Towns of Fort Erie and Niagara-on-the-Lake. Industry is concentrated in these urban areas plus along a largely rural stretch of the Lower Welland River.

THE SAMPLING PROGRAM:

The tributary sampling program commenced on May 31, 1988 and ended on June 1, 1989. The sampling program included a monthly grab sample, a seven day composite sample, and a rain event-oriented component.

The monthly grab samples were taken from thirteen Ontario based tributaries to the Niagara River (Table 2) at the nearest

Table 2: THE THIRTEEN ONTARIO-BASED NIAGARA RIVER TRIBUTARIES STUDIED AND SAMPLING LOCATIONS FOR EACH

Tributary	Sampling Location
a) Gould Ditch	at Niagara Parkway
b) Frenchman Creek	at Phipps Road
c) Miller Creek - Fort Erie	at Miller Avenue
d) Baker Creek	at Schweisler Road
e) Black Creek	at Netherby Road
f) Boyers Creek	at Sherk Road
g) Usshers Creek	at Willick Road
h) Pell Creek	at Front Street
i) Lyons Creek	at Stanley Avenue
j) Grassy Brook	at Montrose Road
k) Welland River	at Montrose Road
l) Thompson's Creek	at Chippawa Creek Road
m) Power Canal	at Whirlpool Road

accessible point to the Niagara River or Chippawa Creek, ensuring no backwater effects. The samples were analyzed for parameter groups A through M in Table 3, however discussion will be restricted to eighteen individual parameters, the NRTMP Chemicals of Concern.

A total of nine rain event-oriented samplings were made during the study, with two samplings occurring in the fall of 1988 and the remaining seven during the period March through May 1989.

During one week each month, a seven day composite sample was collected from the Welland River station, by an automatic sampler. In addition, during the same seven day period, a similar sample was taken from one of the other tributaries, selected on a rotating sequence. Samples from these two stations were collected and analyzed for analytical groups A through G in Table 3.

At the time of each survey, the following measurements were made in the field:

a) streamflow
b) Ph
c) specific conductance
d) dissolved oxygen, and
e) water temperature.

All samples were collected according to established field methodologies, including preservation in the field as appropriate and chilling to approximately 4°C en route to the laboratory. All sample analyses were carried out at the Ministry of Environment and Energy's Central Laboratory in Rexdale according to the methodologies outlined in the Handbook of Analytical Methods for Environmental Samples (MOEE 1983). Appropriate quality assurance/quality control (QA/QC) procedures were followed throughout.

The measurements and the results from the sample analyses were recorded in a database of streamflows and concentrations.

Table 3: PARAMETERS ANALYZED IN NIAGARA RIVER TRIBUTARIES, 1988-89

Test Group	Parameter Type
A	Conventional*
B	Solids
C	Phenolics
D	Biochemical Oxygen Demand
E	Heavy Metals
F	Mercury
G	Free Cyanide
H	Volatile Organics
I	Base-Neutral Extractables
J	Acid Extractables
K	OrganoChlorine Pesticides
L	OrganoPhosphate Herbicides
M	Phenoxy Acid Pesticides

* Includes Nitrogens, Phosphorus, COD, Calcium, Total Alkalinity, etc.

NOTE: The 18 Chemicals of Concern are included in the above test groups E, F, H, I and K.

INTERPRETATION OF RESULTS:

Data for all Chemical of Concern parameters were assembled by sampling location, and screened in terms of the number of samples collected, the number of analyses actually performed for each, and the number of detections of each parameter, noting all exceedences of Provincial Water Quality Objectives (PWQOs). The basic tabulation of the data by tributary appears in Appendix A, while a summary of the occurrence of Chemicals of Concern is presented in Table 4.

Three of the eighteen Chemicals of Concern were not analyzed. In the case of 2,3,7,8 dibenzo-p-dioxin, this was due to the high analytical cost. At the time of the survey, no acceptable method was available for Toxaphene. Octachlorostyrene was analyzed only sparingly and was never detected.

Across the Niagara drainage basin and throughout the one-year duration of the study, a total of 284 samples were collected and analyzed. By far the most frequent result for most priority pollutants, including metals and organics, was "ND", meaning "Not Detected" (See Appendix A). Environmentally, this is the most desirable result possible, indicating the near or complete absence of that pollutant. These results were a major part of the problem in calculating loadings; no substantiable concentration number could be assigned to represent these values.

The three metals, arsenic, mercury and lead, dominated all parameters, each being detected at least three times at every location. Their widespread nature is apparent in Table 4.

Arsenic was detected in 84 of the 284 samples, always at low concentrations, and never exceeding the PWQO of 100 ug/L. Most common in Thompsons Creek, which receives the discharge of the Cyanamid Welland plant, arsenic was present in 14 of 21 samples collected. Earlier studies (Hart, 1983, and Tarandus, 1992) cited arsenic in this vicinity of the Welland River. The Gould Ditch, Fort Erie, yielded arsenic in half the samples.

Mercury was even more common, being found in 182, or almost two thirds of all samples. It too however, was generally found at low concentrations, exceeding the PWQO on just one occasion, in Grassy Brook, in March of 1989.

Lead was similarly ubiquitous, being detected in all tributary streams, but was more sporadic in its occurrence. Lead was "Not Detected" in 173 of the 284 samples collected. However, it exceeded the PWQO on all 111 occasions on which it was detected. While the Method Detection Limit (MDL) was 0.002 mg/L compared to the PWQO of 0.005 mg/L, not a single result fell between these values.

The maximum recorded value was 0.220 mg/L in the Gould Ditch, to which the Gould National Battery plant formerly discharged. Process wastewater was redirected to the Fort Erie municipal sewage

TABLE 4: **Summary of the Occurrence of Niagara River Chemicals of Concern in the Thirteen Tributary Streams, Expressed as the Number of Detections of Each Parameter / Number of PWQO Exceedences.**

	Baker Creek	Black Creek	Boyers Creek	Frenchman Creek	QCP Canal*	Gould Ditch	Grassy Brook	Lyons Creek	Miller Creek	Pell Creek	Thompsons Creek	Usshers Creek	Welland River	Totals
No. of Samples	22	21	20	21	20	19	20	21	20	22	21	20	36	283
Arsenic	5/0	6/0	5/0	5/0	3/0	10/0	6/0	4/0	5/0	9/0	14/0	4/0	7/0	78/0
Chlordane – Alpha						1/0								1/0
– Gamma									1/0					1/0
Chrysene	1/–													1/–
DDT & Metabolites					1/1		2/2		3/3				2/2	8/8
Dieldrin							1/–							1/–
Hexachlorobenzene	1/0				2/2	1/1	1/0				1/0		1/0	7/3
Lead	7/7	11/11	7/7	10/10	9/9	15/15	6/6	6/6	6/6	7/7	9/9	7/7	11/11	111/111
Mercury	16/0	13/0	13/0	15/0	12/0	11/0	16/1	12/1	11/0	13/0	14/0	12/0	24/0	182/2
Mirex								1/1	1/1				1/1	3/3
Tetrachloroethylene	1/0	2/0			2/0	1/0		1/0	1/0	1/0			5/0	14/0

*QCP Canal Refers to Queenston – Chippawa Power Canal

See Tables A1 – A13 for a summary of all sampling results

Note
1 Benz(a)anthracene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, and Benzo(a)pyrene were never detected; no PWQO exists for comparison

2: PCB's were never detected

3: Chrysene was detected once in Baker Creek, but there is no PWQO for comparison

4: Dieldrin was detected once in Grassy Brook, but there is no PWQO for comparison

treatment plant in 1987, and lead-contaminated soils along the ditch were removed. Lead concentrations at this site indicate a continuing source of lead.

The maximum recorded concentration in Black Creek was 0.200 mg/L, while no known sources of lead exist in that basin.

A single sample from Pell Creek peaked at 0.190 mg/L or almost 40 times the PWQO of 0.005 mg/L, during January 1989. Both Washington Mills Electro Minerals Canada Incorporated and Norton Advanced Ceramics Incorporated discharge to Pell Creek, although point source monitoring by MOEE through the same period did not measure effluent concentrations higher than 0.080 mg/L (MOEE, 1993).

Of the PAHs, only Chrysene was ever detected, and that was on only one occasion in Baker Creek, at a concentration of 0.000016 mg/L. No PWQO exists for any of the PAH group, making this value difficult to interpret. The four PAHs other than Chrysene are NRTMP chemicals targeted for 50% reduction in loadings by 1996. The fact that they were not detected in any of the tributaries provides a measure of confidence of their low environmental significance here.

Tetrachloroethylene was detected on a total of 13 occasions, in eight of the tributaries, but never exceeded its PWQO of 50 ug/L. It was most frequently detected in the Welland River, a total of five times out of the 36 sampling dates. It was also detected in Black, Lyons, Miller and Pell Creeks, the Gould Ditch and the Queenston Chippawa Power Canal.

A variety of pesticide parameters was found. Mirex was found and exceeded its PWQO of 0.001 ug/L, once each in Lyons and Miller Creeks and the Welland River. Although formerly manufactured in Niagara Falls, New York, there are no known areas of manufacture or use of this product anywhere within Ontario's Niagara Peninsula. The detection of Mirex in this study is considered an anomaly.

DDT and its metabolites were detected three times in Miller Creek and once in the Welland River. On all these occasions it exceeded its PWQO of 0.003 ug/L. In spite of having been banned for use in Ontario for approximately 20 years, DDT continues to be observed periodically. Such instances generally reflect both the previous widespread use and the environmental persistence of this product.

Hexachlorobenzene was detected sporadically at five locations, once each in Baker Creek, the Gould Ditch, Grassy Brook and the Welland River and twice in the Power Canal. It exceeded its PWQO of 0.0065 ug/L in the Power Canal and Gould Ditch samples.

Alpha and Gamma Chlordane and Dieldrin were each detected on single occasions, in the Gould Ditch, Miller Creek and Grassy Brook, respectively. The Chlordanes did not exceed their PWQO, and no PWQO exists for Dieldrin.

PCBs were never detected in any of the tributaries.

ACTIVITIES SINCE DATA COLLECTION:

Since the time of the 1988-89 tributary survey, a number of significant abatement activities or changes in point source discharges have taken place, affecting the quality of these tributaries. These activities are summarized in Table 5.

CONCLUSIONS:

The most frequent analytical result for all Chemicals of Concern was "Not Detected", indicating the generally excellent water quality conditions throughout the range of tributaries surveyed, relative to these eighteen Chemicals of Concern. Exceedences of Provincial Water Quality Objectives were infrequent for most parameters, with the exception of lead.

The large number of "Non-Detects", combined with sporadic detections at low levels, prevented the reliable calculation of loadings of toxics from the tributaries to the Niagara River. Ontario tributaries are therefore not considered to be a significant source of toxics to the Niagara River.

The widespread occurrence of arsenic, mercury and lead may reflect primarily natural weathering of rocks and soils, or their widespread use in the environment. Arsenic never exceeded the PWQO and mercury exceeded its objective level only once, in Grassy Brook. Arsenic was commonly used for many years as an insecticide and herbicide in various industrial and agricultural applications. However the consistent PWQO exceedences by lead warrant additional attention to confirm the source(s) and investigate reductions.

Of the five PAH compounds tested, there was only a single detection of Chrysene. The remaining four, which are targeted for 50% reduction by 1996 by the Niagara River Toxics Management Plan, were never detected.

The three observations of Mirex, at concentrations exceeding the PWQO, need confirmation, perhaps most effectively by sediment sampling or biomonitoring.

PCBs were never detected in any of the tributaries.

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Table 5: IMPROVEMENTS TO NIAGARA RIVER POINT SOURCE DISCHARGES - INDUSTRIAL

Facility	Treatment Improvement	Anticipated Result
Welland River: Atlas Specialty Steels	Oct 1991 - Demonstration project for removal of highly contaminated (metals) river sediments	Will lead to full scale removal in 1993.
Welland River: Geon Canada (Formerly B. F. Goodrich)	June 1990 - Adopted process for compounding PVC with plasticizes and stabilizers - Installation of distillation column - Stabilization Ponds replaced with equalization basins - Biological treatment increased to tertiary	Decrease in conventional and toxics discharges, particularly Vinyl Chloride monomer.
Welland River: Cyanamid Welland	May 1987 - Nitric Acid, Ammonium Nitrate, and Calcium Phosphate stopped being produced - Installed equalization pond	Decrease in discharge loadings. Shock loadings equalized.

TABLE 5 (Continued): IMPROVEMENTS TO NIAGARA RIVER POINT SOURCE DISCHARGES - INDUSTRIAL

Facility	Treatment Improvement	Anticipated Result
Frenchman Creek: CanadianOxy	Feb 1989 - Contact cooling water from Resin Flaker Belt adapted to Closed Loop June 1993 - Cooling water closed-looped	Eliminated a phenol source Eliminated a point source
Frenchman Creek: Fleet Manufacturing	All process waste streams have been diverted to the municipal sewer system by 1988.	Virtual elimination of metals discharge.
Gould Ditch: Gould National Battery	1987 - Process wastewater redirected to municipal sewer system - Remediation carried out on lead contaminated soil along creek	No longer contributes lead to Niagara River.
Pell Creek: Norton Advanced Ceramics Inc.	Nov 1991 - Contact cooling water changed to closed loop system	Elimination of a point source.

Ford Glass, GenCorp, Stelco StelPipe Tubes, Washington Mills Electrominerals, Washington Mills Ltd, have performed routine and preventative maintenance on existing treatment systems.

TABLE 5 (Continued): IMPROVEMENTS TO NIAGARA RIVER POINT SOURCE DISCHARGES - MUNICIPAL

Facility	Treatment Improvement	Anticipated Result
Welland River: McMaster Avenue CSO	1989 - Diverted to Welland WPCP	Elimination of a point source discharge
Welland River: Niagara Falls WPCP	1993 - Plans underway to provide full Secondary treatment	Improved Effluent quality.
Welland River: Port Robinson Lagoons	1989 - Facility placed in operation	Elimination of real and potential private system discharges.
Welland River: Welland WPCP	1989 - Plant upgraded to Tertiary treatment, or a "polishing" stage of filtration following the conventional secondary treatment process in order to further reduce the organic content of the wastewater.	Improved effluent quality.

APPENDIX "A"

TABLE:A1 SUMMARY OF ANALYSIS AND RESULTS
SOURCE: Baker Creek at Schweisler Road
Number of Sampling Events:22

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. OF NON-DETECTS	NO. DETECTED	RANGE(mg/L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0.001	22	17	5	0.002-0.003	0.100	0
BENZO(A)PYRENE	0.001	18	18	0		–	–
BENZO(B)FLUORANTHENE	0.001	18	18	0		–	–
BENZO(K)FLUORANTHENE	0,001	10	10	0		–	–
BENZ(A)ANTHRACENE	0.001	18	18	0		–	–
CHLORDANE – ALPHA	0.000002	14	14	0		0.00006	0
– GAMMA	0.000002	14	14	0		0.00006	0
CHRYSENE	0.001	18	17	1	0.000015	–	–
DDT & METABOLITES	0.000005	14	14	0		0.000003	0
DIELDRIN	0.000002	14	14	0		–	–
DIOXIN(2,3,7,8-TCDD)	0.00000001	0	0	0		–	–
HEXACHLOROBENZENE	0.000001	14	13	1	0.000006	0.0000065	0
LEAD	0.002	22	15	7	0.006-0.07	0.005	7
MERCURY	0.00001	18	2	16	0.00002-0.00007	0.0002	0
MIREX	0.000005	14	14	0		0.000001	0
OCTACHLOROSTYRENE	0.001	4	4	0		–	–
PCB's(TOTAL)	0.00002	14	14	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	19	18	1	0.00008	0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0

Table:A2 SUMMARY OF ANALYSIS AND RESULTS
SOURCE: Black Creek at Netherby Road
Number of Sampling Events: 21

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. OF NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0.001	20	14	6	0.002	0.100	0
BENZO(A)PYRENE	0.001	17	17	0		–	–
BENZO(B)FLUORANTHENE	0.001	17	17	0		–	–
BENZO(K)FLUORANTHENE	0.001	10	10	0		–	–
BENZ(A)ANTHRACENE	0.001	17	17	0		–	–
CHLORDANE –ALPHA	0.000002	9	9	0		0.00006	0
–GAMMA	0.000002	9	9	0		0.00006	0
CHRYSENE	0.001	17	17	0		–	–
DDT & METABOLITES	0.000005	9	9	0		0.000003	0
DIELDRIN	0.000002	9	9	0		–	–
DIOXIN(2,3,7,8–TCDD)	0.00000001	9	9	0		–	–
HEXACHLOROBENZENE	0.000001	9	9	0		0.0000065	0
LEAD	0.002	19	8	11	0.01–0.2	0.005	11
MERCURY	0.00001	15	2	13	0.00002–0.00007	0.0002	0
MIREX	0.000005	9	9	0		0.000001	0
OCTACHLOROSTYRENE	0.001	16	16	0		–	–
PCB's(TOTAL)	0.00002	8	8	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	18	18	0		0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0

Table:A3

SUMMARY OF ANALYSIS & RESULTS
SOURCE: Boyers Creek at Sherk Road
Number of Sampling Events: 20

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0.001	20	15	5	0.002	0.100	0
BENZO(A)PYRENE	0.001	17	17	0		–	–
BENZO(B)FLUORANTHENE	0.001	17	17	0		–	–
BENZO(K)FLUORANTHENE	0.001	10	10	0		–	–
BENZ(A)ANTHRACENE	0.001	17	17	0		–	–
CHLORDANE –ALPHA	0.000002	9	9	0		0.00006	0
–GAMMA	0.000002	9	9	0		0.00006	0
CHRYSENE	0.001	17	17	0		–	–
DDT & METABOLITES	0.000005	9	9	0		0.000003	0
DIELDRIN	0.000002	9	9	0		–	–
DIOXIN(2,3,7,8–TCDD)	0.00000001	9	9	0		–	–
HEXACHLOROBENZENE	0.000001	9	9	0		0.0000065	0
LEAD	0.002	19	12	7	0.006–0.07	0.005	7
MERCURY	0.00001	15	2	13	0.00002–0.00007	0.0002	0
MIREX	0.000005	9	9	0		0.000001	0
OCTACHLOROSTYRENE	0.001	4	4	0		–	–
PCB's(TOTAL)	0.00002	8	8	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	18	18	0		0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0

Table:A4

SUMMARY OF ANALYSIS & RESULTS
SOURCE: Frenchman Creek at Phipps Road
Number of Sampling Events: 21

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg/L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0.001	21	16	5	0.002 - 0.005	0.100	0
BENZO(A)PYRENE	0.001	18	18	0		-	-
BENZO(B)FLUORANTHENE	0.001	16	16	0		-	-
BENZO(K)FLUORANTHENE	0.001	10	10	0		-	-
BENZ(A)ANTHRACENE	0.001	18	18	0		-	-
CHLORDANE - ALPHA	0.000002	10	10	0		0.00006	0
- GAMMA	0.000002	10	10	0		0.00006	0
CHRYSENE	0.001	18	18	0		-	-
DDT & METABOLITES	0.000005	10	10	10		0.000003	0
DIELDRIN	0.000002	9	9	0		-	-
DIOXIN(2,3,7,8-TCDD)	0.00000001	0	0	0		-	-
HEXACHLOROBENZENE	0.000001	9	9	0		0.0000065	0
LEAD	0.002	21	11	10	0.01 - 0.07	0.005	10
MERCURY	0.00001	16	1	15	0.00002 - 0.00007	0.0002	0
MIREX	0.000005	10	10	0		0.000001	0
OCTACHLOROSTYRENE	0.001	16	16	0		-	-
PCB's(TOTAL)	0.00002	9	9	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	20	20	0		0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0

Table:A5

SUMMARY OF ANALYSIS & RESULTS
SOURCE: Power Canal at Whirlpool Road
Number of Sampling Events: 20

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0 001	20	17	3	0 002-0 04	0.100	0
BENZO(A)PYRENE	0.001	17	17	0		-	-
BENZO(B)FLUORANTHENE	0 001	17	17	0		-	-
BENZO(K)FLUORANTHENE	0 001	10	10	0		-	-
BENZ(A)ANTHRACENE	0 001	17	17	0		-	-
CHLORDANE -ALPHA	0.000002	10	10	0		0 00006	0
-GAMMA	0.000002	10	10	0		0 00006	0
CHRYSENE	0 001	17	17	0		-	-
DDT & METABOLITES	0.000005	10	9	1	0.000005	0 000003	1
DIELDRIN	0.000002	10	10	0		-	-
DIOXIN(2,3,7,8-TCDD)	0 00000001	0	0	0		-	-
HEXACHLOROBENZENE	0.000001	10	8	2	0.000008-0.00046	0.0000065	2
LEAD	0.002	20	11	9	0.006-0.1	0.005	9
MERCURY	0.00001	16	4	12	0 00002-0.00005	0 0002	0
MIREX	0.000005	10	10	0		0 000001	0
OCTACHLOROSTYRENE	0.001	4	4	0		-	-
PCB's(TOTAL)	0.00002	10	10	0		0 000001	0
TETRACHLOROETHYLENE	0.0001	18	16	2	0.00005	0.050	0
TOXAPHENE	N/A	0	0	0		0 000008	0

Table:A6

SUMMARY OF ANALYSIS &RESULTS
SOURCE: Gould Ditch at Niagara Parkway
Number of Sampling Events:20

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0 001	17	17	10	0.002-0.01	0.100	0
BENZO(A)PYRENE	0 001	16	16	0		–	–
BENZO(B)FLUORANTHENE	0 001	16	16	0		–	–
BENZO(K)FLUORANTHENE	0 001	7	7	0		–	–
BENZ(A)ANTHRACENE	0 001	17	17	0		–	–
CHLORDANE -ALPHA	0.000002	10	9	1	0.000002	0 00006	0
-GAMMA	0.000002	10	10	0		0 00006	0
CHRYSENE	0 001	16	16	0		–	–
DDT & METABOLITES	0 000005	10	9	1	1-0.000002	0.000003	0
DIELDRIN	0 000002	10	10	0		–	–
DIOXIN(2,3,7,8-TCDD)	0 00000001	0	0	0		–	–
HEXACHLOROBENZENE	0.000001	9	8	1	0.000017	0 0000065	1
LEAD	0 002	19	4	15	0.007-0.220	0.005	15
MERCURY	0 00001	15	4	11	0.00002-0 00007	0.0002	0
MIREX	0 000005	10	10	0		0 000001	0
OCTACHLOROSTYRENE	0.001	5	5	0		–	–
PCB's(TOTAL)	0.00002	10	10	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	16	15	1	0.0001	0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0

Table:A7

SUMMARY OF ANALYSIS &RESULTS
SOURCE: Grassy Brook at Montrose Road
Number of Sampling Events:20

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0 001	20	14	6	0 002 – 0 005	0.100	0
BENZO(A)PYRENE	0 001	19	19	0		–	–
BENZO(B)FLUORANTHENE	0 001	19	19	0		–	–
BENZO(K)FLUORANTHENE	0 001	12	12	0		–	–
BENZ(A)ANTHRACENE	0 001	19	19	0		–	–
CHLORDANE –ALPHA	0 000002	9	11	0		0 00006	0
–GAMMA	0 000002	11	11	0		0 00006	0
CHRYSENE	0 001	19	19	0		–	–
DDT & METABOLITES	0.000005	11	9	2		0.000003	2
DIELDRIN	0 000002	12	11	1	0.000006	–	–
DIOXIN(2,3,7,8–TCDD)	0 00000001	0	0	0		–	–
HEXACHLOROBENZENE	0 000001	4	4	0		0.0000065	0
LEAD	0.002	20	14	6	0.016–0.08	0 005	6
MERCURY	0.00001	17	1	16	0 00002 – 0.000004	0.0002	1
MIREX	0.000005	11	12	0		0 000001	0
OCTACHLOROSTYRENE	0.001	9	10	0		–	–
PCB's(TOTAL)	0.00002	11	12	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	18	18	0		0.050	0
TOXAPHENE	N/A	0	0	0		0 000008	0

Table:A8

SUMMARY OF ANALYSIS &RESULTS
SOURCE: Lyons Creek at Stanley Avenue
Number of Sampling Events:21

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0 001	21	17	4	0 002	0.100	0
BENZO(A)PYRENE	0.001	18	18	0		–	–
BENZO(B)FLUORANTHENE	0 001	18	18	0		–	–
BENZO(K)FLUORANTHENE	0 001	9	9	0		–	–
BENZ(A)ANTHRACENE	0 001	18	18	0		–	–
CHLORDANE –ALPHA	0 000002	9	9	0		0 00006	0
–GAMMA	0.000002	9	9	0		0 00006	0
CHRYSENE	0 001	18	18	0		–	–
DDT & METABOLITES	0 000005	9	9	0		0.000003	0
DIELDRIN	0 000002	9	9	0		–	–
DIOXIN(2,3,7,8–TCDD)	0 00000001	0	0	0		–	–
HEXACHLOROBENZENE	0.000001	2	2	0		0 0000065	0
LEAD	0.002	21	15	6	0.013–0.07	0 005	6
MERCURY	0.00001	16	4	12	0 00002–0 00003	0.0002	1
MIREX	0.000005	10	9	1	0.000015	0.000001	1
OCTACHLOROSTYRENE	0.001	4	4	0		–	–
PCB's(TOTAL)	0 00002	9	9	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	19	18	1	0 0001	0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0

Table:A9

SUMMARY OF ANALYSIS &RESULTS
SOURCE: Miller Creek at Miller Avenue
Number of Sampling Events:20

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0 001	20	15	5	0.002-0 003	0 100	0
BENZO(A)PYRENE	0.001	17	17	0		-	-
BENZO(B)FLUORANTHENE	0.001	17	17	0		-	-
BENZO(K)FLUORANTHENE	0.001	8	8	0		-	-
BENZ(A)ANTHRACENE	0 001	17	17	0		-	-
CHLORDANE -ALPHA	0 000002	12	12	0		0 00006	0
-GAMMA	0.000002	12	11	1	0 000009	0 00006	0
CHRYSENE	0.001	17	17	0		-	-
DDT & METABOLITES	0.000005	12	9	3	0.000005-0.00001	0 000003	0
DIELDRIN	0.000002	10	10	0		-	-
DIOXIN(2,3,7,8-TCDD)	0 00000001	0	0	0		-	-
HEXACHLOROBENZENE	0.000001	11	11	0		0.0000065	0
LEAD	0.002	20	14	6	0.019-0.06	0.005	6
MERCURY	0.00001	16	5	11	0.00002-0.00004	0.0002	0
MIREX	0.000005	12	11	1	0 00002	0.000001	1
OCTACHLOROSTYRENE	0.001	3	3	0		-	-
PCB's(TOTAL)	0.00002	12	12	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	19	18	1	0.0002	0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0

Table:A10

SUMMARY OF ANALYSIS &RESULTS
SOURCE: Pell Creek at Front Street
Number of Sampling Events:22

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0.001	22	13	9	0 0002	0.100	0
BENZO(A)PYRENE	0.001	16	16	0		–	–
BENZO(B)FLUORANTHENE	0 001	16	16	0		–	–
BENZO(K)FLUORANTHENE	0.001	5	5	0		–	–
BENZ(A)ANTHRACENE	0 001	16	16	0		–	–
CHLORDANE –ALPHA	0.000002	10	10	0		0.00006	0
–GAMMA	0.000002	10	10	0		0.00006	0
CHRYSENE	0 001	16	16	0		–	–
DDT & METABOLITES	0 000005	10	10	0		0 000003	0
DIELDRIN	0.000002	10	10	0		–	–
DIOXIN(2,3,7,8–TCDD)	0 00000001	0	0	0		–	–
HEXACHLOROBENZENE	0 000001	10	10	0		0.0000065	0
LEAD	0 002	22	15	7	0.01–0.19	0 005	7
MERCURY	0.00001	16	3	13	0.00002–0 00014	0 0002	0
MIREX	0 000005	10	10	0		0 000001	0
OCTACHLOROSTYRENE	0.001	3	3	0		–	–
PCB's(TOTAL)	0.00002	10	10	0		0 000001	0
TETRACHLOROETHYLENE	0 0001	18	17	1	0 0002	0 050	0
TOXAPHENE	N/A	0	0	0		0 000008	0

Table A11

SUMMARY OF ANALYSIS &RESULTS
SOURCE: Thompsons Creek at Chippawa Road
Number of Sampling Events: 21

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0 001	21	7	14	0 002-0 004	0.100	0
BENZO(A)PYRENE	0 001	19	19	0		-	-
BENZO(B)FLUORANTHENE	0 001	19	19	0		-	-
BENZO(K)FLUORANTHENE	0 001	11	11	0		-	-
BENZ(A)ANTHRACENE	0 001	19	19	0		-	-
CHLORDANE -ALPHA	0.000002	10	10	0		0 00006	0
-GAMMA	0.000002	10	10	0		0 00006	0
CHRYSENE	0 001	19	19	0		-	-
DDT & METABOLITES	0.000005	11	11	0		0.000003	0
DIELDRIN	0.000002	10	10	0		-	-
DIOXIN(2,3,7,8-TCDD)	0 00000001	0	0	0		-	-
HEXACHLOROBENZENE	0.000001	2	1	1		0.0000065	1
LEAD	0.002	21	12	9	0.007-0.1	0.005	4
MERCURY	0.00001	16	2	14	0.00002-0.00012	0.0002	0
MIREX	0.000005	11	11	0		0.000001	0
OCTACHLOROSTYRENE	0.001	4	4	0		-	-
PCB's(TOTAL)	0.00002	11	11	0		0 000001	0
TETRACHLOROETHYLENE	0.0001	20	20	0		0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0

Table:A12

SUMMARY OF ANALYSIS &RESULTS
SOURCE: Ussers Creek at Willick Road
Number of Sampling Events:20

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0.001	20	16	4	0.002-0.003	0.100	0
BENZO(A)PYRENE	0.001	20	20	0		-	-
BENZO(B)FLUORANTHENE	0.001	20	20	0		-	-
BENZO(K)FLUORANTHENE	0.001	11	11	0		-	-
BENZ(A)ANTHRACENE	0.001	20	20	0		-	-
CHLORDANE -ALPHA	0.000002	10	10	0		0.00006	0
-GAMMA	0.000002	10	10	0		0.00006	0
CHRYSENE	0.001	20	20	0		-	-
DDT & METABOLITES	0.000005	10	10	0		0.000003	0
DIELDRIN	0.000002	10	10	0		-	-
DIOXIN(2,3,7,8-TCDD)	0.00000001	0	0	0		-	-
HEXACHLOROBENZENE	0.000001	13	13	0		0.0000065	0
LEAD	0.002	20	13	7	0.007-0.07	0.005	7
MERCURY	0.00001	14	2	12	0.00002-0.00011	0.0002	0
MIREX	0.000005	10	10	0		0.000001	0
OCTACHLOROSTYRENE	0.001	7	7	0		-	-
PCB's(TOTAL)	0.00002	10	10	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	20	20	0		0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0

Table:A13

SUMMARY OF ANALYSIS &Rs: 20
SOURCE: Welland River at Montrose Bridge
Number of Sampling Events:36

PARAMETER	METHOD DETECTION LIMIT	NO. ANALYSED	NO. NON-DETECTS	NO. DETECTED	RANGE(mg\L)	PWQO	PWQO EXCEEDENCES
ARSENIC	0.001	36	29	7	0.002-0.003	0.100	0
BENZO(A)PYRENE	0.001	29	29	0		-	-
BENZO(B)FLUORANTHENE	0.001	29	29	0		-	-
BENZO(K)FLUORANTHENE	0.001	18	18	0		-	-
BENZ(A)ANTHRACENE	0.001	29	29	0		-	-
CHLORDANE -ALPHA	0.000002	26	26	0		0.00006	0
-GAMMA	0.000002	26	26	0		0.00006	0
CHRYSENE	0.001	29	29	0		-	-
DDT & METABOLITES	0.000005	26	24	2	0.000065	0.000003	2
DIELDRIN	0.000002	26	26	0		-	-
DIOXIN(2,3,7,8-TCDD)	0.00000001	0	0	0		-	-
HEXACHLOROBENZENE	0.000001	26	25	1	0.0000007	0.0000065	0
LEAD	0.002	36	25	11	0.01-0.041	0.005	11
MERCURY	0.00001	27	3	24	0.00002-0.00016	0.0002	0
MIREX	0.000005	26	25	1	0.00002	0.000001	1
OCTACHLOROSTYRENE	0.001	8	8	0		-	-
PCB's(TOTAL)	0.00002	26	26	0		0.000001	0
TETRACHLOROETHYLENE	0.0001	33	28	5	0.00005-0.0004	0.050	0
TOXAPHENE	N/A	0	0	0		0.000008	0